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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PF14L920	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/JP2005/002970	International filing date *(day/month/year)* 17.02.2005	Priority date *(day/month/year)* 26.02.2004
International Patent Classification (IPC) or national classification and IPC H01M8/04, H01M8/06, H01M4/94		
Applicant TOYOTA JIDOSHA KABUSHIKI KAISHA et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 6 sheets, as follows:
      - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the opinion
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

Date of submission of the demand 01.12.2005	Date of completion of this report 16.02.2006
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Horváth, L Telephone No. +49 89 2399-2110

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/JP2005/002970

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-35 as originally filed

Claims, Numbers

1-16 received on 01.12.2005 with letter of 30.11.2005

Drawings, Sheets

1/14-14/14 as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-16
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-9
	No:	Claims	10,11,12,13,14-16
Industrial applicability (IA)	Yes:	Claims	1-16
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Cited documents:

D1: GB-A-1 033 362 (LEESONA CORPORATION) 22 June 1966 (1966-06-22)

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. D1 has been found as representing the closest prior art. D1 discloses a fuel cell with a non-porous hydrogen diffusion palladium-silver alloy electrode (J). Since the palladium-silver alloy membrane only allows hydrogen gas to diffuse through, impure hydrogen gas containing carbon dioxide, carbon monoxide, water, methane, ammonia can be used as the fuel. Electrolyte contamination does not occur.

The problem of hydrogen embrittlement of pure palladium membranes is mentioned in D1 on page 2, lines 122-125. The problem of the present application is that palladium membranes exhibit hydrogen embrittlement at operating temperatures below 200°C. (stated on page 1, lines 20-22). In D1 the pure palladium membrane is replaced therefore with a palladium-silver alloy which has superior mechanical and electrochemical properties and it doesn't demonstrate brittleness even after prolonged periods of exposure to hydrogen (page 2, line 120 - page 3, line 6). The operational temperature of the fuel cell provided by D1 is in the range of 100-300°C.

D1 does not contain any suggestions that the embrittlement of pure palladium membranes can be prevented by reducing a partial pressure of hydrogen in the anode channel as claimed in claim 1. Therefore it appears that claim 1 is novel and inventive over the prior art presently available under Art. 33(1) and (2) and (3).

2. With regard to independent claims 10 and 13 the examining authority is of the opinion that these claims lack an inventive step over document D1. As discussed above D1 discloses a fuel cell using a palladium-silver alloy anode (desc., page 2, lines 21-29). The cathode and the electrolyte are also specifically disclosed (desc., page 2, lines 70-90). D1 specifically discloses that the temperature of the fuel cell must be within the range of 100-300°C. Although specific methods for regulating the temperature of the fuel cell within

these limits, it is considered that it is in the specific knowledge of a skilled man to choose one of the many known possibilities. Therefore the adjustment of the fuel cell temperature by adjusting the temperature of the gas supplied to the fuel cell is a mere choice from obvious possibilities. If the temperature is regulated within the specific limits mentioned on page 3, lines 119-125 of D1 it is also considered implied that the temperature of the fuel cell is measured. This means there is a temperature acquisition section as claimed in claim 10.

The fuel cell system of claim 10 is also equipped with a controller. This controller however is only specified in that it has to be able to detect and regulate the temperature of the fuel cell. As discussed above the fuel cell of D1 also has means for temperature regulation and it is considered that a controller of the type of claim 10 is implicitly disclosed, otherwise it would be impossible to keep the temperature of the prior art fuel cell within the specified limits.

The applicant argues that the prior art fuel cell of D1 functions also in a temperature range below 200°C where embrittlement of palladium occurs. However in none of claims 10-16 there is an indication that the fuel cell claimed in the present application would operate exclusively above 200°C. Furthermore the fuel cell of D1 can also be operated in the temperature range between 200-300°C where the same effect is achieved as in the present application. Although D1 doesn't mention that operating a palladium membrane would prevent embrittlement of the palladium membrane, this effect is achieved regardless of this. The reasoning from above also applies to claim 13 since claim 13 is a mere variation of the subject-matter of claim 10.

For the arguments listed above the examining authority is of the opinion that claims 10-16 lack an inventive step over D1 under Art. 33(3) PCT.

Re Item VIII
Certain observations on the international application

On page 24 line 18 of the description reference sign 244a is used with regard to fig.10. However it was impossible to identify the above mentioned reference sign in fig. 10.

On page 34 the applicant makes reference to the "spirit" of the invention. The meaning of this term is unclear and therefore it is contrary to the requirements of Art. 6. PCT.

In lines 7-9 of claim 10 it is said that the degradation of the hydrogen permeable metal layer is prevented by adjusting the temperature of a gas supplied to the fuel cell. It is not clear in what sense the temperature is adjusted.

CLAIMS:

1. A fuel cell system comprising:

a fuel cell having an electrolyte, a cathode provided at one side of the electrolyte, an anode with a hydrogen permeable metal layer provided at the other side of the electrolyte, a cathode channel for supplying oxidizing gas to the cathode, an anode channel for supplying fuel gas containing hydrogen to the anode;

a hydrogen permeable metal layer degradation prevention section configured to reduce a partial pressure of hydrogen in the anode channel for preventing degradation of the hydrogen permeable metal layer;

a temperature parameter acquisition section configured to acquire a parameter relating to a temperature of the hydrogen permeable metal layer; and

a fuel cell controller for controlling an operation state of the fuel cell system, wherein the fuel cell controller has a degradation prevention mode for causing the hydrogen permeable metal layer degradation prevention section to operate when the temperature of the hydrogen permeable metal layer represented by the temperature parameter deviates from a predetermined temperature range.

2. A fuel cell system according to claim 1, wherein the hydrogen permeable metal layer degradation prevention section includes a gas supply reduction section configured to reduce a partial pressure of hydrogen in the anode channel by decreasing a supply of the fuel gas to the anode channel.

3. A fuel cell system according to claim 1, wherein the hydrogen permeable metal layer degradation prevention section includes:

a hydrogen separation device separating hydrogen in fuel gas; and

a hydrogen concentration reduction section configured to reduce a partial pressure of hydrogen in the anode channel by supplying fuel gas whose hydrogen concentration has been decreased by the hydrogen separation device to the anode channel.

4. A fuel cell system according to claim 3, wherein the hydrogen permeable metal layer degradation prevention section further comprising:

a gas supply reduction section for decreasing a partial pressure of hydrogen in the anode channel by decreasing a supply of the fuel gas to the anode channel; and

the fuel cell controller configured to cause the hydrogen concentration reduction section to operate when a temperature of the hydrogen permeable metal layer represented by the temperature parameter is below a predetermined lower temperature limit, and to cause the gas supply reduction section to operate when a temperature of the hydrogen permeable metal layer represented by the temperature parameter is above a predetermined upper temperature limit.

5. A fuel cell system according to claims 1 to 3, wherein the hydrogen permeable metal layer degradation prevention section includes a low hydrogen concentration gas supply section configured to decrease a partial pressure of hydrogen in the anode channel by supplying gas with a hydrogen concentration lower than the fuel gas to the anode channel.

6. A fuel cell system according to claims 1 to 5, further comprising:

a temperature increase facilitation section configured to facilitate a temperature increase in the hydrogen permeable metal layer; and

a temperature increase mode for causing the temperature increase facilitation section to operate when a temperature of the hydrogen permeable metal layer represented by the temperature parameter is below a lower temperature limit of the predetermined temperature range.

7. A fuel cell system according to claim 6, wherein

the fuel cell includes a heating channel, which is a gas channel for which an oxidizing catalyst is provided, and

the temperature increase facilitation section includes a hydrogen permeable metal layer heating section configured to heat the hydrogen permeable metal layer by supplying gas including a combustible component and a oxidizing component to the heating channel.

8. A fuel cell system according to claims 1 to 7, further comprising a temperature decrease facilitation section configured to facilitate a decrease in temperature of the hydrogen permeable metal layer, wherein

the fuel cell controller includes a temperature decrease mode for causing the temperature decrease facilitation section to operate when a temperature of the hydrogen permeable metal layer represented by the temperature parameter is above an upper temperature limit of the predetermined temperature range.

9. A fuel cell system according to claims 1 to 8, further comprising

a reformer generating fuel gas containing hydrogen from reforming material having hydrogen elements, wherein

the fuel cell controller causes the hydrogen permeable metal layer degradation prevention section to operate while maintaining operation of the reformer.

10.(Amended) A fuel cell system comprising:

a fuel cell having an electrolyte, a cathode provided at one side of the electrolyte, an anode with a hydrogen permeable metal layer provided at the other side of the electrolyte, a cathode channel for supplying oxidizing gas to the cathode, an anode channel for supplying fuel gas containing hydrogen to the anode;

a hydrogen permeable metal layer degradation prevention section configured to prevent degradation of the hydrogen permeable metal layer by adjusting a temperature of gas supplied to the fuel cell;

a temperature parameter acquisition section configure to acquire a parameter relating to a temperature of the hydrogen permeable metal layer; and

a fuel cell controller for controlling an operation state of the fuel cell system, wherein the fuel cell controller has a degradation prevention mode for causing the hydrogen permeable metal layer degradation prevention section to operate when a temperature of the hydrogen permeable metal layer represented by the temperature parameter deviates from a predetermined temperature range.

11. A fuel cell system according to claim 10, wherein

the hydrogen permeable metal layer degradation prevention

section includes a supply gas cooling section configured to cool gas supplied to the fuel cell, and

the fuel cell controller causes the supply gas cooling section to operate when a temperature of the hydrogen permeable metal layer is above a predetermined upper temperature limit.

12. (Amended) A fuel cell system according to claim 10 or 11, wherein

the hydrogen permeable metal layer degradation prevention secion includes a supply gas heating section configured to heat gas supplied to the fuel cell, and

the fuel cell controller causes the supply gas heating section to operate when a temperature of the hydrogen permeable metal layer is below a predetermined lower temperature limit.

13. A fuel cell system comprising:

a fuel cell having an electrolyte, a cathode provided at one side of the electrolyte, an anode with a hydrogen permeable metal layer provided at the other side of the electrolyte, a cathode channel for supplying oxidizing gas to the cathode, an anode channel for supplying fuel gas containing hydrogen to the anode; and

a low temperature gas supply section for supplying gas whose temperature is lower than an operating temperature of the fuel cell to the fuel cell; wherein

the low temperature gas supply section includes a low temperature gas heating section configured to prevent degradation of the hydrogen permeable metal layer due to cooling by the low temperature gas by

heating the gas within a range not reaching an operating temperature of the fuel cell.

14. A fuel cell system according to claim 13, further comprising an auxiliary device whose temperature rises during operation of the fuel cell system, wherein

the low temperature gas heating section heats the low temperature gas by cooling the auxiliary device using the low temperature gas.

15. A fuel cell system according to claim 13 or claim 14, further comprising a high temperature gas supply section for supplying gas whose temperature is higher than an operating temperature of the fuel cell to the fuel cell, wherein

the high temperature gas supply section includes a high temperature gas cooling section configured to prevent degradation of the hydrogen permeable metal layer due to being heated with the high temperature gas by cooling the high temperature gas within a range not reaching an operating temperature of the fuel cell.

16. A fuel cell according to claim 15, further comprising a heat exchanger configure to exchange heat between the low temperature gas and the high temperature gas, wherein

the low temperature gas heating section heats the low temperature gas using the heat exchanger, and the high temperature gas cooling section cools the high temperature gas using the heat exchanger.